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Opportunities for Utilizing the International Space Station for Studies of F2- Region Plasma Science and High Voltage Solar Array Interactions with the Plasma Environment

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The near circular, 51.6° inclination orbit of the International Space Station (ISS) is maintained within an altitude range of approximately 300 km to 400 km providing an ideal platform for conducting in-situ studies of space weather effects on the mid and low-latitude F-2 region ionosphere. The Floating Potential Measurement Unit (FPMU) is a suite of instruments installed on the ISS in August 2006 which includes a Floating Potential Probe (FPP), a Plasma Impedance Probe (PIP), a Wide-sweep Langmuir Probe (WLP), and a Narrow-sweep Langmuir Probe (NLP). The primary purpose for deploying the FPMU is to characterize ambient plasma temperatures and densities in which the ISS operates and to obtain measurements of the ISS potential relative to the space plasma environment for use in characterizing and mitigating spacecraft charging hazards to the vehicle and crew. In addition to the engineering goals, data from the FPMU instrument package is available for collaborative multi-satellite and ground based instrument studies of the F-region ionosphere during both quiet and disturbed periods. Finally, the FPMU measurements supported by ISS engineering telemetry data provides a unique opportunity to investigate interactions of the ISS high voltage (160 volt) solar array system with the plasma environment. This presentation will provide examples of FPMU measurements along the ISS orbit including night-time equatorial plasma density depletions sampled near the peak electron density in the F2-region ionosphere, charging phenomenon due to interaction of the ISS solar arrays with the plasma environment, and modification of ISS charging due to visiting vehicles demonstrating the capabilities of the FPMU probes for monitoring mid and low latitude plasma processes as well as vehicle interactions with the plasma environment.



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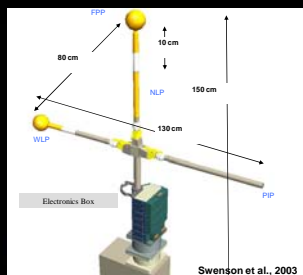
Introduction

The near circular, 51.6° inclination orbit of the International Space Station (ISS) is maintained within an altitude range of approximately 300 km to 400 km providing an ideal platform for conducting in-situ studies of space weather effects on the mid and low-latitude F-2 region ionosphere.



The ISS Floating Potential Measurement Unit (FPMU) instrument suite includes a Floating Potential Probe (FPP), Plasma Impedance Probe (PIP), Wide-sweep Langmuir Probe (WLP), and Narrow-sweep Langmuir Probe (NLP). FPMU was developed by Space Dynamics Laboratory in collaboration with Utah State University [Swenson *et al.*, 2003a,b; Barjatya *et al.*, 2009] and deployed on ISS in 2006. Following initial checkout and on-orbit validation [Coffey *et al.*, 2008; Wright *et al.*, 2008], FPMU data is used to verify ISS charging models, in support of Shuttle and ISS based EVA's, coordination with ISR World Days, and other related engineering activities.

The primary purpose of the FPMU is to characterize ambient plasma temperatures and densities in which the ISS operates and to obtain measurements of the ISS potential relative to the space plasma environment. This data is required to understand and mitigating spacecraft charging hazards to the vehicle and crew. In addition to the engineering goals, data from the FPMU instrument package is available for collaborative multi-satellite and ground based instrument studies of the F-region ionosphere during both quiet and disturbed periods. Finally, the FPMU measurements supported by ISS engineering telemetry data provide a unique opportunity to investigate interactions of the ISS 160 volt solar arrays, visiting vehicles, and attached payload systems with the plasma environment.



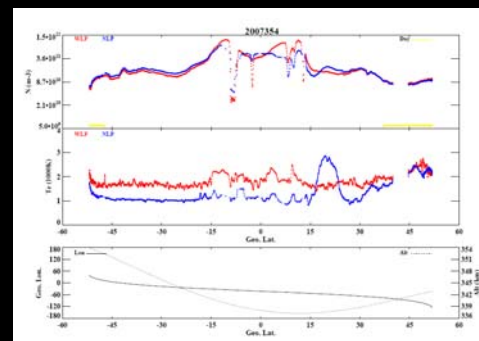
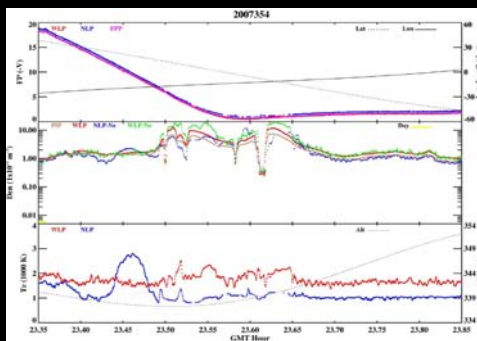
Swenson *et al.*, 2003

| FPMU Parameters | | | |
|-----------------|--------------------|-----------|---|
| Sensor | Measured Parameter | Rate (Hz) | Effective Range |
| FPP | V_F | 128 | -180 to +180 V |
| WLP | N | 1 | 10^9 to $5 \cdot 10^{12} \text{ m}^{-3}$ |
| | T_e | | 500 to 10,000 K |
| | V_F | | -20 to 80 V |
| NLP | N | 1 | 10^9 to $5 \cdot 10^{12} \text{ m}^{-3}$ |
| | T_e | | 500 to 10,000 K |
| | V_F | | -180 to +180 V |
| PIP | N | 512 | $1.1 \cdot 10^{10}$ to $4 \cdot 10^{12} \text{ m}^{-3}$ |

FPMU was mounted to a camera port on the S1 (starboard) Truss from August 2006 to November 2009 and was recently moved to the current location on the P1 (port) Truss. Data is encoded in a video signal and down linked via the Ku-band video system. The camera interface allows for high bandwidth telemetry (6,776 12-bit words, 1 32-bit word) each second.

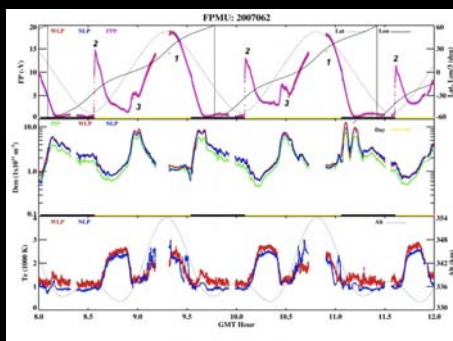
Equatorial Plasma Depletions

The altitude of the ISS near circular orbit is maintained between ~300 km and 400 km providing opportunities to regularly sample plasma environments near the peak electron density in the F2 region ionosphere. Observations from the ISS platform complement those provided by other ionospheric spacecraft including C/NOFS (~400 x 850 km x13°), DMSP (~800 km circular, 99°), and CHAMP (~470 km circular, 87°).

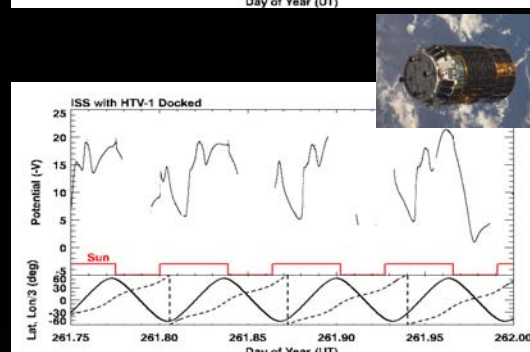
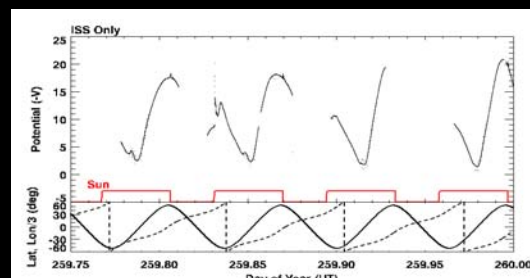


Solar Array Plasma Interactions

ISS structure is grounded to the negative end of the 160 volt solar arrays. As a result, FPMU monitors variations in structure potentials generated by current collection on the ISS solar arrays as well as currents collected by visiting vehicles.



1. Magnetic induction (vxB)-L
2. Eclipse exit solar array charging
3. Equatorial noon solar array charging



References

- Barjatya *et al.*, Invited article: Data analysis of the Floating Potential Measurement Unit aboard the International Space Station, *Rev. Sci. Instruments*, **80**, 041301, 2009.
- Coffey *et al.*, Validation of the plasma densities and temperatures from the ISS Floating Potential Measurement Unit, *IEEE-Trans. Plasma Sci.*, **36**, Issue 5 Part 2, 2301, 2008.
- Swenson *et al.*, Calibrating the floating potential measurement unit, *8th Spacecraft Charging Technology Conference*, Huntsville, Alabama, 20-24 October 2003.
- Swenson *et al.*, The Floating Potential Measurement Unit, *AIAA-2003-1081*, 4th Aerospace Sciences Meeting and Exhibit, Reno, Nevada, 2003.
- Wright *et al.*, Charging of the International Space Station as observed by the Floating Potential Measurement Unit: Initial results, *IEEE-Trans. Plasma Sci.*, **36**, Issue 5 Part 2, 2280, 2008.

